APPARATUS AND METHOD FOR DISPENSING WRAPPER AND WRAPPING PRODUCTS

CROSS-REFERENCE TO OTHER APPLICATIONS

[001] This application claims the benefit of U.S. Provisional Application No. 60/442,912 filed January 28, 2003, which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[002] The present invention relates generally to product wrapping systems and, more particularly, to systems for dispensing wrapper stock onto product rolls that require wrapping. Such systems are typically capable of wrapping rolls of varying lengths and diameters.

BACKGROUND OF THE INVENTION

[003] The wrapping of rolls of product of varying diameters and lengths is common in many industries. A current system for wrapping product rolls, such as paper rolls, is depicted in Fig. 1. Product roll 150 has a typical cylindrical shape with its round end face 1501 being shown in Fig. 1. A length in the axial direction of product roll 150 runs perpendicular to the plane of the drawing sheet. Due to the varying lengths of product roll 150, wrapper supply rolls 101-104 having multiple widths of wrapper stock 121-124, respectively, are typically staged at an overhead (or rear) location near a wrapping station 140. The wrapper stock can be paper or plastic film. The widths of wrapper stock 121-124 are also measured in the axial directions of the respective wrapper supply rolls 101-104, which in Fig. 1 run perpendicular to the plane of the drawing sheet. An example of wrapper stock rolls having different widths can be seen at 211 in Figs. 4A and 4B. In Fig. 1, wrapper supply rolls 101-104 and product roll 150 are arranged with their axes running parallel. In addition, the wrapper supply rolls 101-104 are typically arranged with respect to a centerline 149 (Fig. 1A) of wrapping station 140 so that the centerline 149, which runs parallel to the plane of the drawing sheet containing Fig. 1 and perpendicular to the axes of the wrapper supply rolls 101-104, would bisect the widths of all wrapper stock 121-124. This arrangement is shown in Fig. 1A where

wrapper supply rolls 101 and 102 are arranged with the centerline 149 of wrapping station 140 bisecting their widths. Product roll 150 must then be centered with respect to the centerline of wrapping station 140 so that the centerline also bisects the length of the product roll 150. Thus, both end faces 1501, 1502 (Fig. 1A) of the product roll 150 can be properly wrapped. For a predetermined length of product roll 150, the proper width of wrapper stock, e.g., 121, is identified, either manually or automatically, and selected for dispensing through a number of bend rollers 131-133, 161-164 (Fig. 1) onto product roll 150. The bend rollers 131-133, 161-164 are typically idler rollers, and are used to guide the wrapper stock through a zigzag path, e.g., 101-131-161-145, into the wrapping station 140. More particularly, the bend rollers are rollers at which the wrapper stock changes its direction. In system 100, there are other rollers that also guide the wrapper stock but do not change its direction. These rollers are called support rollers designated at 181-184. The currently available technology typically utilizes a series of wrapper backstands or dispensing stations 120 and a wrapping station 140 that requires that the multiple wrapper stock widths 121-124 be pre-fed into the wrapping station 140. The dispensing stations 120 are capable of feeding any single width, e.g., 121, selected for dispensing. This can be done by rotating the selected wrapper supply roll, e.g., 101, to unwind wrapper stock 121.

[004] Fig. 1B shows an alternative, low-profile arrangement of the conventional wrapping system, in which the dispensing station 120 and wrapping station 140 are generally co-elevational.

[005] One problem with existing systems of the above type relates to the process required to pre-feed many different widths of wrapper stock, 121-124, into one machine, e.g., wrapping station 140, and the process required to replenish wrapper stock. As can be seen at 145 in Fig. 1, many different widths of wrapper stock, 121-124 are pre-fed into wrapping station 140. When the proper width wrapper stock, e.g., 121, is selected, only wrapper stock 121 will be fed between turning rollers 170 and product roll 150 to wrap the product roll. Nevertheless, the other, unselected widths of wrapper stock 122-124 need to be present in wrapping station 140, ready for dispensing in case one of them will be selected in the next wrapping operation of a product roll having a different length. The dispensing and wrapping operations are usually performed automatically in a known manner, i.e., an automatic controller

(not shown) determines the length of product roll 150, selects the proper width of wrapper stock 121, controls the dispensing of the wrapper stock 121 from the respective wrapper supply roll 101 and its feeding into wrapping station 140, and, after product roll 150 has been completely wrapped and discharged to warehouse, repeats the process for the subsequent product roll. However, when a roll of wrapper stock, e.g., 101, is running low or is nearly used up, an operator is required to take the system out of automatic mode before the wrapper 121 runs out and then manually cut and splice the end of the new roll of wrapper stock (not shown) to the tail of the pre-fed sheet 121, e.g., by taping the new and old wrappers. This splice then needs to be run forward, through the respective bend rollers, e.g., 131, 161, and into the wrapping station 140 before allowing the system to be put back into automatic mode. This results in lost production time and requires operator labor.

[006] A second problem with these systems is the fact that large areas of wrapper stock are left exposed to the ambient environment, for example, with respect to wrapper stock 121, in the areas 191 (Fig. 1B) between bend rollers 131-161 and wrapping station 140. In the case of Kraft paper wrapper stock, this can result in loss of moisture content which adversely contributes directly to wrapped package quality, (i.e. edge crimping of the final package is inferior when moisture content falls too low).

[007] A third problem with these systems is that the pre-fed wrapper stock is often left resting on the floor and is dragged on the floor which can result in the introduction of contaminants on the wrapper stock. This can be seen again in Fig. 1, in the areas 191 between bend rollers 131 and 161.

[008] A fourth problem with these systems is that the pre-fed wrapper stock, e.g., 121, is directed across the bend rollers, e.g., 131-161, to feed it into the wrapping station 140. It is a common problem with wrapper left bent over a roller (especially bend rollers 131-134) for it to take a slight "set" around the bend roller such that it is slightly deformed. The deformations will be more likely to become permanent if the wrapper, e.g., 124, is not used for a long time, e.g., because its width is not suitable for wrapping a series of product rolls. These deformations in the sheet, e.g., 124, can cause jamming and mis-feeds within the

wrapping station 140 when the sheet 124 is eventually used. A jammed or mis-fed wrapper results in loss of valuable production time and requires operator labor to clear the jam.

[009] A fifth problem with these systems is the difficulty of clearing jams and mis-feeds of wrapper. With wrapping station 140 that has multiple sheets pre-fed at the same time into a single area (e.g., 141), by its nature, the internal fingers (at 145) of wrapping station 140, that are required to guide and separate the multiple wrappers inside the wrapping station of dispenser 140, leave little room for wrapper build up during a jam or mis-feed. Additionally, the access to the internal components of most dispensers is very limited as can be seen in Fig. 1 at 145. Consequently, the time it takes to clear a jam can be as high as 30 minutes or more. The process of clearing the jam can even lead to damaging of the drive rollers, fingers, or wrapper guides inside the wrapping station 140, e.g., in the region generally designated by reference numeral 145.

[010] A sixth problem with these systems is the means by which the wrapper, e.g., 121, is tensioned as it is applied to the product roll 150. Typically, this is accomplished by variable speed control between the wrapping station 140 and/or backstand/dispensing stations 120 and the drive of the turning rollers. If there is a mismatch of speeds between the drives, wear occurs on the drive rollers 170, which are often rubber covered for gripping. Consequently, the drive rollers must be replaced regularly and if a particular wrapper width is used frequently, then the corresponding drive roller also has to be replaced more frequently. This translates to a higher cost of repair.

[011] A seventh problem with these systems exists for cases where the industry practice of "overlap wrapping" is employed. Overlap wrapping is the process of using two or more wrappers of different widths, e.g., 121-122, applied in an offset and overlapped fashion onto the product roll in order to accomplish the task of wrapping an ultra wide product roll 150. Because a single width of wrapper stock is not available in the industry for ultra wide product rolls, overlap wrapping is the only means to wrap some ultra wide product rolls. Fig. 1A schematically shows an overlap wrapping operation. First, ultra wide product roll 150 is placed in Position A so that a part 157 thereof can be wrapped with wrapper stock 121 dispensed from wrapper supply roll 101. Then, the product roll 150 must be moved relative

to the centerline 149 of the wrapping station 140 and dispensing stations 120 (not shown in Fig. 1A), i.e., in the axial direction of the product roll to Position B where another part of product roll 150, i.e., 158, can be wrapped with wrapper stock 122 dispensed from wrapper supply roll 102. The overlap part 159 is where the product roll 150 is wrapped with both wrapper stock 121 and 122. Of course, the movement of product roll 150 from Position A to Position B requires that the product roll be handled with additional equipment. Because the product rolls can weigh up to several thousand pounds, this means higher initial cost for the system as well as another long-term maintenance cost of repair.

SUMMARY OF THE INVENTION

[012] It is an object of the present invention to provide an apparatus for and a method of wrapping product that can address some or all of the problems listed above for the existing systems.

[013] More particularly, it is an object of the present invention to provide a wrapping system that does not require wrapper stock to be pre-fed into its wrapping station.

[014] It is another object of the present invention to provide a wrapping system that does not require splicing when replenishing spent wrapper stock rolls.

[015] It is a further object of the present invention to provide a wrapping system that does not leave large areas of wrapper stock sitting exposed to ambient conditions and/or allow the wrapper stock to make contact with the floor or slide over or against adjacent wrapper stock.

[016] It is yet another object of the present invention to provide a wrapping system that does not employ bend rollers or induce deformations across the width of a wrapper stock sheet, thereby eliminating wrapper jams.

[017] It is yet a further object of the present invention to provide a wrapping system that can offset wrapper stock location at will without having to move the heavy product roll to accomplish overlap wrapping of the product roll.

[018] It is still another object of the present invention to provide a wrapping system that controls wrapper tension via a vacuum or electrostatic belt conveyor, or the like.

[019] One or more of the above and other objects of the present invention are achieved by an apparatus for feeding a wrapper stock (or wrapping web) to a wrapping station where a product is to be wrapped with the wrapping web. The apparatus comprises a backstand for holding a supply roll of the wrapping web and for unwinding and rewinding the wrapping web from the supply roll, and a conveyor for transporting the wrapping web unwound from the supply roll to the wrapping station.

[020] Preferably, the conveyor comprises a vacuum conveyor belt, or an electrostatic conveyor belt, or a moving belt having a non-skid surface, or the like.

[021] In accordance with an aspect of the present invention, the wrapping web is dispensed from the supply roll to the conveyor along a path which is free of bend rollers.

[022] In accordance with another aspect of the present invention, the apparatus further comprises an elongated guiding element having a first end located below and adjacent the backstand for receiving a lead edge of the wrapping web, and a second, opposite end located above and adjacent the conveyor for guiding the lead edge of the wrapping web to fall under gravity onto the conveyor.

[023] Preferably, the backstand comprises two chuck portions and a driving mechanism for driving the chuck portions. In chucking motion, the chuck portions are driven by the driving mechanism to move relative to each other to engage a core of the supply roll, the chuck portions being adapted to rotate the core in opposite directions to unwind and rewind the wrapping web, respectively. In shuttling motion, the driving mechanism drives the chuck portions along an axial direction of the product roll, without changing the distance between the chuck portions, to adjust to a length of the product to be wrapped, e.g., when overlap wrapping is required.

[024] Preferably, the driving mechanism comprises two elongated, threaded shafts, a motor and a transmission box. Each of the chuck portions is movably arranged on one of the shafts. The transmission box selectively transmits torque between the motor and both of the shafts,

thereby effecting the chucking motion of said chuck portions toward or away from each other and the shuttling motion of said chuck portions together along the axial direction of the product to be wrapped.

[025] One or more of the above and other objects of the present invention are also achieved by a method of wrapping a product with a wrapping web stored on a supply roll. The method comprises unwinding the wrapping web from the supply roll; feeding a lead edge of the wrapping web to a wrapping station using a conveyor; and wrapping the product with an unwound length of the wrapping web.

[026] In accordance with an aspect of the present invention, the feeding step comprises allowing the lead edge of the wrapping web to fall under gravity directly on the conveyor; and using the conveyor to transport the lead edge and, successively, the unwound length of the wrapping web to the wrapping station.

[027] Preferably, the method further comprises cutting the wrapping web after the wrapping has been completed; and rewinding an unused portion of the unwound length of the wrapping web onto the supply roll, leaving a short length of the wrapping web dangling loosely above the conveyor.

[028] In accordance with another aspect of the present invention, the method further comprises controllably varying the unwinding speed of the supply roll and/or the moving speed of the conveyor and/or the wrapping speed of the turning rollers, depending on a position of the lead edge of the wrapping web on the conveyor, thereby tensioning the wrapping web. Preferably, if the conveyor includes a vacuum belt, the vacuum strength of the vacuum belt can also be regulated to maintain positive control of the wrapping web, depending on the position of the lead edge of the wrapping web on the belt.

[029] One or more of the above and other objects of the present invention are further achieved by a wrapping system that has a dispensing station comprising multiple backstands each for containing a supply roll of a wrapping web and dispensing the wrapping web from said supply roll; a wrapping station for wrapping a product with the wrapping web from at least one of said backstands, said wrapping station comprising a pair of rollers on which the

product is to be cradled, the wrapping web being fed between said rollers and the product in a wrapping operation of said wrapping station; and a conveyor arranged under said dispensing station for receiving the wrapping web from said at least one of said backstands, which wrapping web falls under gravity on said conveyor, said conveyor extending up to said rollers of said wrapping station for transporting the wrapping web thereto.

[030] In accordance with an aspect of the present invention, the system further comprises a wrapping web selector moveable with respect to the backstands to feed the wrapping web from at least one of said backstands to said conveyor.

[031] In accordance with another aspect of the present invention, the system is able to shift the supply roll relative to the wrapping station in an axial direction of the supply roll.

[032] Other and further objects, features and advantages will become apparent from the following description of the presently preferred embodiment of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[033] The present invention is illustrated by way of example, and not by limitation, in the figures of the accompanying drawings, wherein elements having the same reference numeral designations represent like elements throughout, and wherein:

[034] Fig. 1 is a schematic elevational side view showing a dispensing station in a conventional wrapping system;

[035] Fig. 1A is a schematic view showing the overlap wrapping operation in the conventional wrapping system;

[036] Fig. 1B shows an alternative, low-profile arrangement of the conventional wrapping system;

[037] Fig. 2 is a schematic elevational side view showing the dispensing station and wrapping station of a wrapping system in accordance with a first embodiment of the present invention;

[038] Fig. 3 is an enlarged view of a portion of Fig. 2 that partially shows a conveyor belt of the dispensing station and turning rollers of the wrapping station of the system of Fig. 2;

[039] Figs. 4A and 4B are front views showing a backstand of the dispensing station of Fig. 2 with wrapper supply rolls of different widths, wherein Fig. 4B shows a wrapper supply roll centered with respect to the centerline of the wrapping station and Fig. 4A shows another wrapper supply roll shifted relative to the centerline of the wrapping station;

[040] Fig. 5 is a schematic elevational side view showing the dispensing station in accordance with a second embodiment of the present invention;

[041] Fig. 6 is a schematic elevational side view showing the dispensing station in accordance with a third embodiment of the present invention;

[042] Fig. 7 is a schematic elevational side view showing the dispensing station in accordance with a fourth embodiment of the present invention;

[043] Fig. 8 is an enlarged view showing backstands of the dispensing station of Fig. 7;

[044] Fig. 9 is an enlarged view showing a wrapper selection carriage of the dispensing station of Fig. 7;

[045] Fig. 10 is an enlarged view showing components of a wrapping station to be used in accordance with the present invention;

[046] Figs. 11A-11D schematically show the system in accordance with the second embodiment of the present invention in operation;

[047] Fig. 12A shows a plan view of the driving mechanism for driving the chuck portions or carriages in shuttling and chucking motion of each backstand in accordance with the present invention;

[048] Fig. 12B shows a partial front view of the driving mechanism of Fig. 12A; and

[049] Figs. 12C and 13D show simplified, left side views of the driving mechanism of Fig. 12B in different operation modes.

DETAILED DESCRIPTION OF THE INVENTION

[050] Before the embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangements of components set forth in the following description or illustrated in the drawing. The invention is capable of other embodiments and of being practiced or being carried out in various ways. Also, it is understood that the phraseology and terminology used herein are for the purpose of description and should not be regarded as limiting. The use of letters to identify steps of a method or process is simply for identification and is not meant to indicate that the steps should be performed in a particular order.

[051] Generally, the inventive apparatus includes a plurality of backstands each holding a supply roll. Advantageously, the wrapping webs or wrapper stock is dispensed from one supply roll at a time onto a moving conveyor which transports the wrapper stock to a wrapping station without using bend rollers. In accordance with an unique aspect of the present invention, after the wrapping operation has been completed, the wrapper stock is rewound onto its supply roll, rather than being left exposed on the conveyor or in the wrapping station. Another novel feature of the present invention resides in the unique arrangement in which the supply rolls, rather than the product roll, are shifted for overlap wrapping. The present invention advantageously provides a novel wrapping system and method in which the wrapping web can be automatically fed on demand to the wrapping station without human intervention and without the need for pre-feeding the wrapping web into the wrapping station before the proper width of wrapper stock is selected.

[052] In the below sections, the embodiments of the invention will explained in detail.

[053] Figs. 2 and 5-7 are schematic elevational side views showing the dispensing station and wrapping station, or wrapper/dispenser, of a wrapping system in accordance with first-fourth embodiments of the present invention, respectively.

[054] In the first embodiment shown in Figs. 2-3, a product 2010, e.g., a paper roll, is wrapped at wrapping station 240 with a wrapper or wrapper stock or wrapping web, e.g.,

201-204, dispensed from supply rolls 211-214, respectively. Preferably, only one of the supply rolls 211-214 dispenses its wrapper stock at a time. If overlap wrapping is required, the selected supply rolls will dispense wrapper stock in sequence. The supply rolls 211-214 as well as product 2010 are generally arranged with their longitudinal axes in a horizontal direction. The product 2010 is cradled by turning rollers 321/322. The supply rolls 211-214 are rotatably held, unwound and rewound by backstands 221-224 (described below with respect to Figs. 4A-4B), respectively, of dispensing station 220. In Fig. 2, dispensing station 220 can also include a spare wrapper roll holding pocket 225 to hold a spare supply roll 215. The supply rolls 211-215 are transported to the backstands 221-224 or spare wrapper roll holding pocket 225 by an overhead transporting mechanism 216. The transporting mechanism 216 generally includes an overhead rail 2161 extending immediately above each of the backstands 221-224 and holding pocket 225. A clamp 2162 moves along the rail 2161. Any other means for transporting supply rolls to the dispensing station 220, e.g., conveyors, can be used with the present invention.

[055] Each of backstands 221-224 is provided with a wrapper stock deflection chute 231-234, respectively, into which the free or lead edge of wrapper stock is fed down under the force of gravity. The chute's function is to introduce the lead edge of the wrapper stock down onto a wrapper conveyance system or conveyor 250 at an obtuse angle, e.g., a3 (Fig. 2), to the running direction, e.g., d2 (Fig. 2), of the conveyor. Additionally, the chute's function is to control the degree of curl on the lead edge (e.g., 2015, Fig. 11A) of the wrapper stock (e.g., 201) in the chute. Each chute includes at least one elongated metal sheet, as can be seen in Fig. 5 at 531-534. Of course, other suitable materials can be used instead of metal. In the first embodiment of Figs. 2-3, each chute 232-234 includes two elongated metal sheets designated at, e.g., 2341 and 2342, respectively. The elongated metal sheets, e.g., 2341-2342, are slanted with respect to each other to define a V-shaped structure as shown in Fig. 2, at 232-234. The chute 231 has only one elongated metal sheet which, together with a section (251) of the conveyor 250, forms the V-shaped structure. The elongated metal sheets are preferably fixed to a stationary supporting platform 229 of dispensing station 220 on which the backstands 211-214 are supported. Other arrangements, including moveable attachment of the chutes to the supporting platform 229, are possible. The surfaces of the elongated metal sheets that may come into contact with the wrapper stock (e.g., the inwardly facing surfaces of metal sheets

2341-2342) are generally planar and should not obstruct smooth movement of the wrapper stock through the V-shaped structure down to the conveyor.

[056] The V-shaped structure of the chutes includes an inlet, e.g., 2343 (Fig. 2), adjacent and below the respective supply roll 214, and a outlet, e.g., 2344, adjacent and above the respective section (252) of conveyor 250. Each of the supply rolls 211-214 are positioned in the respective backstands, 221-224, so that the free or lead edges of the wrapper stock of the supply rolls 211-214 dangle loosely in the V-shaped structures of the respective chutes 231-234. Although Fig. 2 shows by phantom lines that wrapper stock 201-204 are all drawn down to the conveyor 250, it should be understood that only one of the wrapper stock, e.g., 201, is drawn down to and carried by conveyor 250 to wrapping station 240 at a time. The wrapper stock 202-204 of the other supply rolls 212-214 should be rewound onto their supply rolls with their lead edges dangling loosely in the corresponding chutes 232-234. As can be seen at 2021 and 2022 which designate the paths of the wrapper stock 202 in the situations when the supply roll 212 is full and when the supply roll 212 is nearly used up, respectively, the wrapper stock 202 always extends in a generally straight line, due to gravity, when it is drawn down to conveyor 250. The same applies to the wrapper stock of other supply rolls 211, 213-214. The use of bend rollers as well as the wrapper deformation problem associated therewith are thus advantageously avoided in accordance with the present invention.

[057] Conveyor 250 is located directly beneath all of the backstands 221-224 such that wrapper stock fed down (under gravity and by rotating the respective supply rolls in an appropriate direction, e.g., counterclockwise) from any of the wrapper stock rolls or supply rolls 211-214 will be received on moving conveyor belts 251-252 of conveyor 250. Vacuum, electrostatic, non-skid surfaces or other means, are employed by conveyor 250 to maintain positive control of the wrapper stock as it makes contact with the upper runs of the conveyor belts.

[058] Conveyor 250 includes primary feed belt 251, secondary feed belt 252, intermediate belt 253 and belt finger table 254. The primary feed belt 251 and secondary feed belt 252 are preferably vacuum conveyor belts that are mounted below the backstand structural support 229. The primary vacuum feed belt 251 will preferably run continuously regardless of which

backstand is paying out wrapper stock. The primary feed belt 251 is also the main feed conveyor for the leftmost backstand 221. The secondary feed belt 252 serves as a secondary vacuum feed to redirect wrapper stock to the primary feed belt 251 from three of the four backstands 222-224. The secondary feed belt 252 and/or the intermediate belt 253 and the belt finger table 254 may run continuously as well.

[059] Each of the conveyor belts, e.g., 253 (best seen in Fig. 3), includes an endless belt 2531 trained around two pulleys 2532, 2533, each having a rotational axis that is arranged generally horizontal. One of the pulleys, e.g., 2532, is a driving pulley which is driven by a conveyor belt drive (not shown), e.g., a motor. The other pulley, e.g., 2533, is an idler which is driven by the driving pulley 2532 and the endless belt 2531. It is also within the scope of the present invention to provide both pulleys 2532-2533 as driving pulleys. The conveyor belts can have separate pulleys, e.g., conveyor belt 254, or shared pulleys, e.g., pulley 2532 which is shared between conveyor belt 251 and conveyor belt 253. One of the pulleys, e.g., 2532, defines the infeed location of the respective conveyor belt 253, whereas the other pulley, e.g., 2533, defines the outfeed location of the conveyor belt 253.

[060] Each of the conveyor belts, e.g., 253, has an upper run 2534 and a lower run 2535. In operation, the upper run 2534 runs from the infeed location 2532 to the outfeed location 2533, positively controls and carries the wrapper stock's thereon in the running direction, e.g., d3, of the conveyor belt 253. The respective lower run runs in the opposite direction. If vacuum belts are used, a vacuum box (not shown) is positioned below the upper run 2534, or lower run 2535, of conveyor belt 253. The vacuum strength can be desirably varied as will be described hereinbelow.

[061] As can be best seen in Fig. 3, the conveyor belts of conveyor 250 extend consecutively from locations immediately beneath the outlets of chutes 231-234 up to turning rollers 321-322 of wrapping station 240. Preferably, the outfeed location of an upstream conveyor belt, e.g., 251, is placed adjacent the infeed location 2532 of the next, downstream conveyor belt, e.g., 253, to ensure smooth transition of the wrapper stock from the upstream conveyor belt to the next downstream conveyor belt 253. Alternatively, the outfeed location 2523 of an upstream conveyor belt, e.g., 252, can be placed adjacent and above the upper run

and in a middle region 2516 of the next, downstream conveyor belt, e.g., 251. Other arrangements are possible as long as the wrapper stock can be smoothly transferred from one conveyor belt to the next conveyor belt. Likewise, the last conveyor belt 254 has a outfeed location 2543 that is adjacent the nip 320 between turning rollers 321/322 and product 2010 so as to smoothly transfer the wrapper stock into the nip.

[062] Also shown in Fig. 3 are a full width wrapper slitter 362, a dual hot melt glue gun system 363, and a glue drip pan 364. Preferably, the wrapper slitter 362 and dual hot melt glue gun system 363 are positioned in a region between the outfeed location 2533 of conveyor belt 253 and the infeed location 2542 of the last conveyor belt 254. An advantage of this arrangement resides in that if glue guns drip, they will not drip on the belting material of conveyor belts 253-254. Rather, all glue drips will pass between the conveyor belts 253-254 and will be collected in the underlying glue drip pan 364.

[063] All of the downstream vacuum belt conveyors (253, 254) are successively engaged, after wrapper stock is pre-fed from the overhead primary vacuum feed belt 251, to secure the lead edge of the wrapper stock in a vacuum pinning action and maintain control of the wrapper stock as it is accelerated down and into the nip of the turning rollers 321-322.

[064] The unique backstands in accordance with the present invention will now be described with reference to Figs. 4A-4B. The backstands are configured with the capability of chucking and shuttling motions. In particular, the backstands or wrapper unwind/rewind stations are each capable of chucking up wrapper stock or supply rolls of varying widths and diameters. Each backstand, e.g., 221, has two carriages (or chuck portions) 411, 412 that can be moved such that they approach each other or move away from each other, in a chucking motion. Thus, backstand 221 can hold supply rolls of different widths as can be seen in Fig. 4A and 4B.

[065] Advantageously, the same mechanical means are employed to move the carriages 411, 412 to the right or left in unison while maintaining a fixed distance therebetween, in a shuttling motion. This can be achieved by the driving mechanism generally designated at 415 which will be described hereinbelow with reference to Figs. 12A-C. Other means for moving the backstand 221, such as a hydraulic cylinder, can also be employed.

[066] At least one of the carriages, e.g., 411, has a "pay-out" drive or motor 419 that engages with the wrapper stock roll, e.g., 211, allowing the wrapper stock to be unwound from or rewound onto the wrapper stock roll as required. The motor 419 of carriage 411 engages supply roll 211 at its hollow core. The speed and rotational direction of the "pay-out" drive are controllably adjusted depending on the dispensing and wrapping operations.

[067] In accordance with a preferred embodiment of the present invention, the driving mechanism 415 in Fig. 12A includes two elongated, threaded shafts 1311, 1312, a motor 416 and a transmission box 1320. Preferably, the elongated, threaded shafts 1311, 1312 are acme screws. Each acme screw, e.g., 1311, has opposite unthreaded ends 1314, 1315 which is supported by a frame 1350 of driving mechanism 415 via bearings 1316, 1317. The bearings 1316, 1317 supports the acme screw 1311 while allowing the acme screw to rotate about its axis1318. Most of the length of the acme screw 1311, i.e., the portion between the unthreaded ends 1314, 1315, is threaded. In Fig. 12A, only two ends 1319, 1313 are illustrated to have threads. However, it should be understood that the threaded portion extends from the end 1319 to the end 1313. The same applies to the other acme screw 1312.

[068] Each of carriages 411, 412 is moveably arranged on one of the acme screws 1311, 1312, respectively. Each carriage 411, 422 has a nut 4115, 4125, respectively, fixed thereto, e.g., by welding. The nuts 4115 and 4125 have internal threads that match the external threads of acme screws 1311, 1312, respectively. Thus, when one of the acme screws, e.g., 1311, rotates, e.g., clockwise, the respective nut 4115, and hence the respective carriage 411, will move to the left of Fig. 12A, i.e., towards the motor 416. Likewise, when the acme screw 1311, rotates counterclockwise, the respective nut 4115, and hence the respective carriage 411, will move to the right of Fig. 12A. The same applies to the other set including acme screw 1312, nut 4125, and carriage 412. One of the acme screws, i.e., 1311 is shorter than the other acme screw 1312, and therefore the respective carriage 411 cannot move beyond the position of its bearing 1317. This location defines a limit to the shuttling motion of the carriages 411/412 and is predetermined based on the wrapper stock widths the system of the present invention is designed to handle.

[069] Rotation of the acme screw 1311, 1312 is driven by motor 416 via the transmission box 1320. Motor 416 has an output shaft 4165 extending into the transmission box 1320, the motor 416 is preferably capable of reversing its rotational direction. Transmission box 1320 selectively connects the output shaft 4165 of motor 416 to the acme screws 1311-1312 and the manner the transmission box 1320 connects the output shaft 4165 of motor 416 to the acme screws will dictate how the acme screws will rotate and, accordingly, how the carriages 411-412 will be moved relative to each other.

[070] In particular, transmission box 1320 includes two clutches CL1 and Cl2, and two sets of gears. The first set includes gears 1321-1322 (Fig. 12C) which are meshed with one another when the clutch CL1 is engaged. The second set includes gears 1323-1325 (Fig. 12D). When the clutch CLC is engaged, gear 1323 is meshed with gear 1324 which, in turn, is meshed with gear 1325. The gears 1321 and 1323 are arranged on the unthreaded end 1334 of acme screw 1312. The gears 1322 and 1325 are arranged on the unthreaded end 1314 of acme screw 1311.

[071] The unique chucking motion of the present invention will now be described. When the clutch CL1 is engaged and clutch CL2 is disengaged, gears 1321 and 1322 are meshed, but gears 1323 and gears 1325 are not meshed with one another via gear 1324. As a result, torque is transmitted from the motor 416 via output shaft 4165 to both gears 1321 and 1322 which drive the acme screws 1312 and 1311, respectively, to rotate in opposite directions. For example, if the output shaft 4165 rotates clockwise, gear 1321 and acme screw 1312 will rotate clockwise whereas gear 1322 and acme screw 1311 will rotate counterclockwise. Therefore, carriage 412 will move to the left in Fig. 12A and carriage 411 will move to the right in Fig. 12A. In other words, the carriages 411 and 412 move toward each other in a chucking motion. If the rotational direction of motor 416 is reversed, the carriages 411 and 412 will move away from each other.

[072] The unique shuttling motion of the present invention is achieved when the clutch CL1 is disengaged and clutch CL2 is engaged. In this case, gears 1321 and 1322 are not meshed, but gears 1323 and gears 1325 are meshed with one another via gear 1324. As a result, torque is transmitted from the motor 416 via output shaft 4165 to both gears 1323 and 1325 which drive the acme screws 1312 and 1311, respectively, to rotate in the same direction. For example, if

the output shaft 4165 rotates clockwise, gear 1323 and acme screw 1312, as well as gear 1325 and acme screw 1311 will rotate clockwise. Therefore, both carriages 412 and 411 will move to the left in Fig. 12A. If the rotational direction of motor 416 is reversed, the carriages 411 and 412 will move to the right in Fig. 12A.

[073] Advantageously, the gear ratios of the two gear sets 1321/1322 and 1323/1324/1325 as well as the thread pitches of the acme screws 1311/1312 and their corresponding nuts 4115/4125 are chosen so that in the shuttling motion, the carriages 411 and 412 move in unison. In a preferred embodiment of the present invention, the gear ratios between gears 1321/1322 and gears 1323/1325 are 1, and the thread pitches of the acme screws 1311/1312 and their corresponding nuts 4115/4125 are the same. Thus, the carriage 411 always travels, e.g., to the left in Fig. 12A, the same distance as the carriage 412. This safety feature is important because a supply roll that has been held between carriages 411-412 will not be accidentally dropped during shuttling motion which could happen if the distance between the carriages, for unexpected reasons, increases.

[074] In accordance with the present invention, the shuttling motion of the backstand is preferred for overlap wrapping as described above with respect to Fig. 1A. As can be seen in Fig. 4B, when overlap wrapping is not required, i.e., when the width of the wrapper stock of supply roll 211 alone is sufficient to wrap product 2010, the supply roll 221 is preferably centered with respect to the centerline 149 of wrapping station and the product 2010. However, when overlap wrapping is required, i.e., when at least two supply rolls are needed to wrap product 2010, at least one of the supply roll, e.g., 211, should be shifted relative to the centerline 149 as shown in Fig. 4A. The overlap wrapping operation in accordance with the present invention is similar to the process described in Fig. 1A, with the important exception that the product 2010 is advantageously kept motionless while at least one of the supply rolls is being shifted off the centerline 149 by novel shuttling motion of the respective backstand. The shifted supply roll can be either of the supply rolls selected for overlap wrapping, e.g., 101 or 102 in Fig. 1A.

[075] However, it is within the scope of the present invention to shift both supply rolls off the centerline 149 for overlap wrapping. Of course, more than two supply rolls may be required to

wrap an extra long product, in which case, at least two of the supply rolls will need to be shifted. Likewise, only one supply roll can be sufficient for overlap wrapping if the supply roll is shifted, after the a first half of the product has been wrapped by said supply roll, to wrap the second half of the product. This process apparently takes more time to completely overlap wrap the product than when two different supply rolls are used, because in the later case one of the two supply rolls can be shifted during the wrapping of the first half of the product by the other roll.

[076] The operation of the wrapping system in accordance with the first embodiment of the present invention will now be described.

[077] At the beginning of the dispensing operation, by feeding the wrapper stock, e.g., 201, off the respective supply roll, e.g., 211, at a speed slightly slower than the speed of the conveyor belts of conveyor 250, the wrapper stock is influenced to "square up" and run in line with the conveyor belts such that the lead edge of the wrapper stock will be squarely introduced in the nip between the turning rollers 321/322 and product roll 2010. As the wrapper stock is fed down the conveyor 250 toward the turning rollers 321/322, the unwinding speed of the motor, e.g., 419 in Fig. 4A, and the running speed of the conveyor belts are matched.

[078] Glue or electrostatic means (not shown) or the like can be employed to adhere the lead edge of the wrapper stock to the product roll 2010.

[079] When a proper length of wrapper stock has been dispensed, a slitter or cutting means (362, in Fig. 3) is employed to cut the wrapper to length. This cutting creates a tail or trail edge of the wrapper length being used to wrap the product roll 2010, and a new lead edge of the unused wrapper stock that needs to be rewound onto its supply roll 211, as will be discussed hereinbelow with reference to Figs. 11A-11D. As the tail or trail edge of the wrapper is drawn into the nip of the turning rollers 321-322 and product roll 2010, trail edge glue, or the like, is applied. Also, as the tail or trail edge of the wrapper is drawn into the nip, the backstand, e.g., 221, that just fed the wrapper, e.g., 201, toward the product roll 2010 begins to rewind the remaining wrapper stock 201 left on the conveyor 250 back onto the wrapper stock or supply roll 211. The conveyor belts of conveyor 250 continue to convey

toward the turning rollers 321/322 to help keep the remaining wrapper stock 201 aligned with its supply roll 211 as it is rewound.

[080] When the new lead edge of the wrapper stock 201 being rewound approaches the throat, i.e., the outlet, of the respective chute 231, the wrapper stock 201 is decelerated and brought to a stop such that the new lead edge is in the throat of the chute 231 directly above the surface of the conveyor belt 251. Thus, a length of the wrapper stock 201 is left dangling loosely (freely suspended) above the conveyor belt 251, ready for the subsequent dispensing and wrapping operations.

[081] If the next incoming product roll has a different width, the "pay-out" drive, e.g., 419 in Fig. 4A, of the active backstand will reverse to reel the entrained sheet clear of the primary and secondary feed belts. When the wrapper sheet has cleared, the next appropriate backstand "pay-out" drive will repeat the above steps.

[082] If the next incoming product roll requires an overlap wrap (i.e., the next product roll is too wide, e.g., wider than 51"), the "pay-out" drive of the active backstand will reverse to reel the entrained sheet clear of the primary and secondary feed belts. When the wrapper sheet has cleared, two or more pre-selected backstands will shuttle to stagger themselves relative to one another for the overlap wrap function. When in position, the first backstand will dispense the wrapper sheet to wrap the first half of the roll. When the first half of the roll is completely wrapped, the first backstand will reel the entrained sheet clear of the conveyor 250 to allow the second backstand to wrap the second half of the roll. The overlap wrapped roll will be longitudinally glued at the seam if required.

[083] Fig. 5 depicts a second embodiment of the dispensing station in accordance with the present invention. This is a "low profile" embodiment in which the dispensing station 520 is arranged generally coelevational with the wrapping station 240.

[084] Like the dispensing station 220 of Fig. 2, each of backstands 521-524 is provided with a wrapper stock deflection chute 531-534, respectively, into which the free or lead edge of wrapper stock is fed down under the force of gravity. The chute in this embodiment is an elongated element, e.g., a metal sheet.

[085] Conveyor 550 is located directly beneath all of the backstands 521-524 such that wrapper stock fed down from any of the wrapper stock rolls or supply rolls 211-214 will be received on moving conveyor belt 551 of conveyor 550. Again, vacuum, electrostatic, non-skid surfaces or other means, are employed by conveyor 550 to maintain positive control of the wrapper stock as it makes contact with the conveyor belt. The conveyor belts (551, 553) of conveyor 550 extend consecutively from locations immediately beneath the outlets of chutes 531-534 up to turning rollers 321-322 of wrapping station 240. Unlike the first embodiment where all or most of the conveyor belts 251-254 are slanted with respect to the horizontal, in the second embodiment, the conveyor 550, and more particularly conveyor belt 551, runs substantially horizontally.

[086] It should be noted that conveyor belt 553 in the second embodiment can be replaced with a finger table known in the art. In the first embodiment, the last section of the conveyor 250, i.e., 254, is preferably a vacuum moving belt in order to maintain positive control of the wrapper stock on the conveyor's surface. As described hereinbelow, during the wrapping operation, the speed of the turning rollers 321/322 (i.e., wrapping speed) is slightly higher than the moving speed of the conveyor 250 to thereby stretch the wrapper stock. This stretching, in addition to the large inclination degree of the conveyor 250 (down from 251 to 253 to 254), tend to lift the wrapper stock off the conveyor's surface. Therefore, all section of the conveyor 250 up to the nip 320 should be configured to maintain the wrapper stock on the conveyor's surface, by e.g., vacuum. However, in the second embodiment, the conveyor 550 is mostly horizontal, or inclined at an insignificant angle, and therefore the possibility of the wrapper stock being lifted off the conveyor's surface is not as high as in the first embodiment. Accordingly, the last section 553 of conveyor 550 can be replaced by a conventional finger table to reduce cost.

[087] The operation of the second embodiment is similar to the first embodiment, and will be described with reference to Figs. 11A-11D. First, after the proper width of wrapper stock has been selected, the selected wrapper stock, e.g., 201, is unwound from the respective supply roll 211, as illustrated in Fig. 11A. The unwinding speed of supply roll 211, e.g., 100 feet/minute is controlled by the respective backstand 521. The conveyor belt 551 moves at a moving speed slightly higher than the unwinding speed, e.g., at 110 feet/minute, from (or,

preferably, before) the moment the lead edge 2015 of the wrapper stock 201 touched the surface of conveyor belt 551 until the lead edge 2015 has traveled a predetermined distance to reach position ① in Fig. 11A. During this period, the moving speed of the lead edge 2015, as well as the subsequent length of wrapper stock received on the conveyor belt 551, is higher than the unwinding speed of the supply roll 211. This causes the wrapper stock 201 to square up and run in line with the conveyor belt 551.

[088] During the next period when the lead edge 2015 travels with conveyor belt 551 from position ① (Fig. 11A) to position ② (Fig. 11B) just before it enters the nip between turning rollers 321/322 and product roll 2010, the unwinding speed of the supply roll 211 and the moving speed of the conveyor 551 are gradually increased to the wrapping speed at which turning rollers 321/322 rotate. Preferably, the moving speed of the lead edge 2015 is about equal to the wrapping speed of turning rollers 321/322, e.g., 350 feet/minute, when the lead edge 2015 enters the nip.

[089] After the lead edge 2015 has entered or passed the nip (position ③ in Fig. 11C), the moving speed of the conveyor belt 551 is maintained at a level slightly lower than the wrapping speed of turning rollers 321/322, e.g., at about 348 feet/minute. At the same time the unwinding speed of the supply roll 211 is maintained at a level slightly higher than the wrapping speed of turning rollers 321/322, e.g., at about 350.2 feet/minute. These speed relationships provide a slack of the wrapper stock near the supply roll 211 and stretch the wrapper stock immediately before entering the nip between turning rollers 321/322 and product 2010.

[090] When the wrapping operation is about to be completed, i.e., an appropriate number of convolutions has been applied to product 2010, the wrapper stock 201 is cut by wrapper slitter 362, creating trail edge 2016 and a new lead edge 2015', as can be seen in Fig. 11D. Trail edge 2016 is fixed to the wrapped product 2010 by appropriate means, such as glue. Then, the turning rollers 321/322 decelerate to a complete stop to discharge the wrapped product. The backstand 521 reverses the rotation of supply roll 211 to rewind the unused length of wrapper stock 201 lying on the conveyor belt 551 until the new lead edge 2015' reaches position ④ where it dangles freely just above conveyor belt 551, ready for the next wrapping operation. At the same time, conveyor belt 551 continues to move forward. However, the moving speed of

conveyor belt 551 is gradually reduced to the initial level of e.g., 110 feet/minute. Thus, in the next wrapping operation when the supply roll 211 is selected again, the new lead edge 2015' is allowed to fall under gravity (by unwinding supply roll 211) from position ④ on the conveyor belt (as shown in Fig. 11A), and the process repeats.

[091] Preferably, when the conveyor belts of conveyor 550 are vacuum belts, the vacuum strength of the vacuum belt can also be controlled during the wrapping process. For example, before the lead edge 2015 enters the nip between turning rollers 321/322 and product 2010, the vacuum strength of the conveyor belts should be sufficient to maintain control of the wrapper stock on the conveyor belts' surface. However, after the lead edge 2015 has passed the nip and attached to the product 2010, e.g., by glue, the vacuum strength of the conveyor belts can be reduced, e.g., in half, to save energy.

[092] Fig. 6 depicts a third embodiment of the dispensing station in accordance with the present invention. Although, the wrapping web of wrapper stock, in accordance with the present invention, is best fed exclusively downwardly as sown in Fig. 2 or at least horizontally as shown in Fig. 5, it is still within the scope of the present invention to provide a conveyor 650 which has one or more sections that run slightly upwardly as shown at 653 in Fig. 6. This is possible because the conveyor belts of conveyor 650 maintain positive control of the wrapper stock, by vacuum or electrostatically or by other suitable means, as the wrapper stock makes contact with the conveyor belts. In other aspects, the third embodiment is similar to the second embodiment.

[093] Fig. 7 depicts a fourth embodiment of the dispensing station in accordance with the present invention. Unlike the previous embodiments of the present invention where the wrapping web falls directly under gravity on the conveyor 250, 550, or 650, the wrapping web in this embodiment is caught by a wrapper selector carriage 775 which then brings the wrapping web to a conveyor 750 supported by a structure 785. In other aspects, i.e., the backstands 221-224 and the wrapping station 240, the fourth embodiment is similar to the first embodiment. The most significant different aspects, i.e., the wrapper selector carriage 775 and conveyor 750 will be best described with reference to Figs. 8-9.

[094] Fig. 8 shows the wrapper selector carriage 775 in different locations with respect to backstands 221-224. The wrapper selector carriage 775 is movably supported by a rail system (not shown) below the structure 291 that supports the backstands 221-224. The wrapper selector carriage 775 includes two pivoting nip rollers, one, 881, is rubber covered and driven by a gear motor (not shown), and the other, 882, serves as an idler. The nip rollers have generally horizontal rotational axes. The nip rollers are housed in the carriage that is gear motor driven (not shown) along the rail system. The nip rollers are preferably pneumatically actuated, by, e.g., pneumatic cylinder 885 which moves one of the nip rollers, e.g., 882, toward the other, e.g., 881 to catch the downwardly fed wrapper stock therebetween. One nip roller arm has an integral anvil or back bar 888, the other nip roller arm houses an integral slitter mechanism or serrated breaking bail 889 to cut the wrapper.

[095] When wrapper selection (width) has been decided by the controller, the wrapper selector carriage 775 moves immediately to the position below the chute, e.g., 232 in Fig. 8, of the backstand, e.g., 222, from which wrapper stock of the desired width is to be fed. Once the wrapper selector carriage 775 has reached its position, the "pay-out" drive for that backstand, in this case 222, will unwind wrapper 202 down into the wrapper selector carriage 775. A sensor (not shown) is provided in the wrapper selector carriage 775 to detect the presence of the downwardly fed wrapper. Preferably, the sensor is an optical sensor.

[096] When the wrapper has triggered the sensor, the nip rollers 881-882 will engage, by actuating the cylinder 885, to entrain the lead edge 2025 of the wrapper 202. Once the wrapper's lead edge 2025 is entrained, the wrapper selector carriage 775 will be driven by a traversing drive (not shown) to move along the rail system, to the wrapper feed position above the conveyor 750, carrying the wrapper 202 along with it as it moves. The "pay-out" drive of backstand 222 will synchronize itself with the wrapper selector carriage 775 traversing drive to allow the control unwinding of wrapper stock 202 from the supply roll 212 as the wrapper selector carriage 775 moves to the wrapper feed position illustrated in Fig. 7.

[097] Once the wrapper selector carriage 775 is in the wrapper feed position, the nip feed drive (not shown) that drives the nip roller 881 will begin to feed wrapper stock 202 down to

the wrapper selector carriage 775. The "pay-out" drive of the backstand 222 continues to synchronize with the nip feed drive as needed.

[098] The structure 785 is best illustrated in Fig. 9. The structure 785 includes two pivoting nip rollers 981 and 982, at least one (981) of which is driven by a gear motor 968, and the other, 982, serves as an idler. The nip roller 982 is preferably pneumatically actuated, by, e.g., cylinder 985 which moves one of the nip rollers, e.g., 982 toward the other, e.g., 981, to catch the wrapper stock 202 therebetween. A sensor (not shown) is provided in the structure 785 to detect the presence of the downwardly fed wrapper 202. Preferably, the sensor is an optical sensor.

[099] When the wrapper 202 is sensed to be inside the structure 785, the pneumatic cylinder 985 (it is also within the scope of the present invention to use other means, such as hydraulic cylinders) is activated to move the idler roller 982 from the open position (solid line) to the closed position (phantom line) to close the nip. The drive of the nip 881-882 of wrapper selector carriage 775 will go into idle. The "pay-out" drive of the backstand 222 will now synchronize with drive 968 of nip rollers 981-982. Thus, drive 968 will begin to feed wrapper onto conveyor 750 which, like in the previously described embodiments, include several sections 969, 970, 971 angled with respect to each other. The structure of the conveyor 750 is mostly similar to the structure of conveyor 250. As the nip 981-982 closes, the vacuum generator (not shown) of the infeed vacuum conveyor belt 969, similar to conveyor belt 251 of the first embodiment, will be activated. Conveyor 750 also includes an intermediate vacuum tape guide conveyor 970, similar to conveyor belt 253 of the first embodiment, and a vacuum belt finger table 971, similar to conveyor belt 254 of the first embodiment, which serves to administer wrapper smoothing and tension control during wrapping.

[0100] A "lead edge" sensor will sense the lead edge of the wrapper stock 202, and glue is applied to the lead edge as it passes under a bank of hot melt glue guns (not shown). Only the guns inside the width of the product roll being wrapped will administer glue, (the wrapper overhang will be left glue-free). The wrapper continues down and the lead edge goes into the nip formed by the product roll and the turning rollers 321, 322 (Fig. 7). When the

appropriate length of wrapper has been dispensed to finish an appropriate number (e.g., 1-1/3 to 2) convolutions around the product roll, the wrapper stock is severed on the fly at the wrapper selection carriage 775 by means of elements 888 and 889.

[0101] After cutting, the trail edge of the wrapper stock will be sensed by the "lead edge" sensor and the bank of hot melt glue guns will administer a shot of glue to the trail edge as it is passes by. At the same time, the backstand 212 that fed the wrapper stock 202 reverses the rotational direction of the respective supply roll 212 to rewind the unused, already dispensed length of wrapper stock 202 onto the supply roll 212 until the new free, lead edge (obtained after cutting) of wrapper stock 202 is received in the respective chute 232. The turning rollers 312-322 will continue to turn until the wrapper overhang has all been crimped by crimper wheels 1074 (Fig. 10) before decelerating to a stop. The wrapped and crimped product roll will then be moved to a discharging station (not shown). The next product roll is conveyed into the wrapping station as the wrapped roll is conveyed to the discharging station. When the next product roll is centered in the wrapping station, the turning rollers 321-322 will lift to cradle the product roll for wrapping and the cycle is repeated with the appropriate width of wrapper.

[0102] The structure 785 is configured so that a product roll can be wrapped with stretch-film in lieu of kraft wrapper should that be required. In order for the stretch wrapper to apply the lead edge of the stretch film to the product roll, the intermediate tape guide belt 970 and vacuum belt finger table 971 are arranged to retract or back away from the nip of the turning rollers 321-322, as shown by phantom line in Fig. 9. The lead edge of the stretch-film can then be taped to the product roll to initiate the stretch wrapping sequence.

[0103] In accordance with the fourth embodiment wrapper stock is always being fed downward taking advantage of gravity to allow the wrapper stock to lay and travel naturally. Advantageously, once entrained in the nip or nip rollers 981-982, the wrapper stock, e.g., 202, is always positively controlled with vacuum tape conveyor belts throughout its travel to the nip of turning rollers 321-322 and the product roll.

[0104] Moreover, when the lead edge of wrapper enters the turning roller nip 320 (Fig. 3) the speed of the main drive roller 981 will be made slightly faster than the product roll's turning

speed, the vacuum generator of the intermediate vacuum tape guide conveyor belt 970 is shut down and its speed is matched to the product roll's turning speed. This allows for a "slack zone" for the wrapper stock. Further, the speed of vacuum belt finger table 971 and its vacuum setting are adjustable to tune for optimal smoothing and wrapping tension control. Normally, the speed of vacuum belt finger table 971 will be slightly slower than the product roll's turning speed and its vacuum level will be increased. These features act together to effect constant control of the tail or trail edge of wrapper stock with respect to tension and smoothing as it enters the nip and makes contact with the product roll during wrapping.

[0105] The relative angle between the infeed (969) and intermediate (970) vacuum belt conveyors is adjustable to optimize the wrapper transition from conveyor to conveyor. This applies to other embodiments as well.

[0106] It should be noted that the dispensing process of the fourth embodiment involves the use of several bend rollers, but unlike the conventional systems, the bend rollers of the present invention do not cause deformation of the wrapper stock and do not adversely affect the wrapping quality. As can be seen in Fig. 8, when the backstand 221 dispenses wrapper stock 201 from supply roll 211, the downwardly fed wrapper stock 201 is caught between the nip of nip rollers 881/882. As the wrapper selector carriage 775 moves to the wrapper feed position of Fig. 7, the wrapper stock 201 is trained around rollers 2318, 2319 positioned in chute 231 below backstand 221. These rollers 2318, 2319 change the direction of the wrapper stock and are, therefore, bend rollers. Similarly, nip rollers 881 (Fig. 8) and 982 (Fig. 9) can be considered bend rollers as well. However, unlike the conventional bend rollers, the "bend" rollers 2318, 2319, 881 and 982 of the present invention do not cause deformations in the wrapper stock 201, because the wrapper stock 201 is trained around the rollers 2318, 2319, 881 and 982 only when the wrapper stock 201 moves. Therefore, no portion of the wrapper stock 201 is bent over the rollers 2318, 2319, 881 and 982 for a sufficiently long time so as to deform. Since the wrapper stock in accordance with the present invention is not pre-fed to the wrapping station 240, but instead rewound onto the respective supply roll after each wrapping operation, the wrapper stock is not left bent over the rollers, does not deform and, therefore, does not cause jams in the wrapping station 240.

[0107] Fig. 10 is an enlarged view showing components of the wrapping station 240 to be used in the present invention. The major components include support base 1070, turning rollers 321-322 with lift cylinder 1071, linear carriage 1072 with pivot cylinder 1073, dual crimper arms 1075 (only one can be seen in Fig. 10) with crimper wheels 1074.

[0108] Support base 1070 incorporates a fixed driven roller 321 for rotating the product roll during the wrapping cycle. A pivoting lift arm 1076 is fitted with an idle roller 322 actuated via hydraulic cylinder 1071 that lifts the product roll off a conveyor and cradles it with the opposite driven roller 321. In particular, arm 1076 moves from the position shown in Fig. 7 to the position shown in Fig. 10.

[0109] Each crimper arm 1075 is mount to a single carriage 1072 that traverses horizontally on a linear track assembly. There are two substantially identical such carriages. The track will carry the left hand carriage 1072 and the right hand carriage (invisible in Fig. 10) driven by independent gear-motor belt drives. The traverse distance of each carriage is sized to effectively engage a product roll of any width within a predetermined range, e.g., from 15" to 90", which product roll has been centered on the turning roller pocket 320 of wrapping station 240. The linear track assembly and the carriages are pivoted together by hydraulic or pneumatic cylinder 1073 through an approximately 90^{o} arc. The retracted position of hydraulic cylinder 1073 can be seen in Fig. 7 whereas the extended position is shown in Fig. 10.

[0110] Each crimper arm 1075 pivots independently via pneumatic cylinder 1077. The crimper blade paddles 1078 is driven by a VFD (variable frequency drive) gear motor for proper crimping pitch control with varying product roll diameters. The cylinder 1077 of crimper arm 1075 is in the fully extended position in Fig. 7, where cylinder 1073 of the linear track assembly and the carriages 1072 is in the retracted position. The cylinder 1073 then extends to pivot the linear track assembly and the carriages 1072 about 90^{o} counterclockwise, while the cylinders 1077 of the crimper arms 1075 being maintained in the extended position. Subsequently, the cylinders 1077 of the crimper arms 1075 retract to reach the retracted position shown in Fig. 10. In the retracted position, the crimper wheel 1074 makes full contact with the cradled product roll in the turning roller pocket 320. The carriage drives

will be used to administer a pneumatic crimp press function to insure a tight fold with the roll edge.

[0111] When the roll is properly cradled on the turning roller, the carriages will pivot 90° to engage the product roll. The crimper wheels' contact with the product roll will initiate the wrapping cycle. When the lead edge of the wrapper has made its way around the product roll and sensed, by a sensor (not shown), at the crimper wheels 1074, the crimp press cycle will be initiated and held until the entire product roll is wrapped. When the wrapping cycle is complete, the carriages will pivot 90° disengaging the wrapped roll. The turning roller 322 will lower the wrapped roll back onto the conveyor and the conveyor will advance in the forward direction until the wrapped roll has completely transferred onto the discharging area and the next product roll has centered on the centerline of the wrapping station.

[0112] An advantage of the system of the present invention is that it is jam-free, by eliminating some of the common features that have historically contributed to wrapper jams in conventional dispenser technology. The present invention does not uses wrapper clamps or bend rollers. The wrapper stock in accordance with the present invention is never "pushed" but is always controlled and conveyed through the conveyor. Preferably, the wrapper stock is always routed downward and never upward. The wrapper stock is not pre-threaded around bend rollers that can induce a "set" in the wrapper stock which can contribute to jamming.

[0113] Another advantage of the present invention is that depleted wrapper rolls are replenished virtually automatically. In accordance with the present invention, the operator is not required to tape or splice the tail of the depleted roll to the lead edge of the new wrapper roll and/or manually thread the spliced wrapper through the dispensing station up to the wrapping station. The operator just chucks up the new wrapper roll in the backstand, and pays-out about 3 feet of the wrapper lead edge down into the chute to the conveyor.

[0114] Another advantage of the present invention is that the belts of the conveyor are arranged such that if glue guns drip, they will not drip on belting material. This can be achieved by staggering vacuum belt strands to allow openings for glue gun drip access to the

drip pan mounted below the conveyor belt. In other words, all drips from the glue guns will be collected in the drip pan mounted underneath the belts.

[0115] Variations and modifications of the foregoing are within the scope of the present invention. It is understood that the invention disclosed and defined herein extends to all alternative combinations of two or more of the individual features mentioned or evident from the text and/or drawing. All of these different combinations constitute various alternative aspects of the present invention. The embodiments described herein explain the best modes known for practicing the invention and will enable others skilled in the art to utilize the invention. The claims are to be construed to include alternative embodiments to the extent permitted by the prior art. Various features of the invention are set forth in the following claims.